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Impact of Sodium Fluoride (NaF) Toxicity in Acute and Chronic Conditions on the Teeth of Albino Rats (*Rattus norvegicus*)

Diksha N. Athawale[1], Milind D. Kale[2]

[1]Research Scholar, Department of Zoology, Govt. Vidarbha Institute of Science and Humanities, Amravati
Email: *diksha5260[at]gmail.com*

[2]Assistant Professor, Department of Zoology, Govt. Vidarbha Institute of Science and Humanities, Amravati
Email: *milindrck19[at]gmail.com*

Abstract: ***Dental caries remains one of the most prevalent chronic diseases observed in humans and experimental animals, as chemical agents are used in various formulations. Sodium fluoride (NaF) is one of the chemical agents which is widely used for its preventive effects against dental decay; however, excessive or prolonged exposure may cause dental fluorosis and enamel degeneration. Dental assessments were conducted to evaluate changes in tooth color and enamel integrity. Results showed that acute exposure led to yellowish discoloration, whereas chronic exposure caused degeneration of enamel and tooth edges. These findings indicate that sodium fluoride, while effective in preventing dental decay, can induce structural alterations in teeth if administered in high doses or for prolonged periods. The study underscores the importance of careful regulation of sodium fluoride intake and provides insights for optimizing its use.***

Keywords: sodium fluoride, enamel degeneration, tooth decay

1. Introduction

Sodium Fluoride is widely used in dentistry to reduce tooth decay. However, recent studies raise concerns about its adverse effects, prompting a critical evaluation of its overall impact on dental health.

Dental caries is one of the most common chronic oral diseases, affecting both humans and animals worldwide (Petersen et al., 2005). Fluoride is widely recognized for its protective role in preventing dental caries by enhancing enamel remineralization and inhibiting demineralization (Ten Cate & Featherstone, 1991). Among various fluoride compounds, sodium fluoride (NaF) is frequently used in public health programs, dental care products, and experimental studies due to its proven cariostatic properties (Marinho, 2014).

However, while low concentrations of fluoride strengthen tooth enamel and prevent decay, excessive or prolonged exposure may lead to toxic effects, including dental fluorosis a condition characterized by enamel discoloration, pitting, and structural weakness (Fejerskov et al., 1990; DenBesten & Li, 2011). Fluoride toxicity has been reported not only in human populations exposed to high-fluoride water but also in experimental animals subjected to chronic fluoride administration (Shanthakumari et al., 2004).

Experimental models such as albino rats (*Rattus norvegicus*) are extensively used to study fluoride-induced dental changes because their tooth structure and mineralization processes resemble those of humans (Whitford, 1996). Investigating both acute and chronic effects of sodium fluoride exposure in such models helps in understanding the mechanisms of fluoride toxicity and its implications for oral health.

The present study aims to evaluate the effects of sodium fluoride on the teeth of albino rats (*Rattus norvegicus*), with particular attention to enamel alterations, discoloration, and morphological degeneration under different exposure conditions. This research contributes to the growing understanding of fluoride's dual role both as a preventive and potentially harmful agent depending on its dosage and duration of exposure.

2. Material and Method

Experimental Design

The present experimental study was carried out on healthy adult albino rats (*Rattus norvegicus*). The animals were divided into three groups: a control group, an acute exposure group, and a chronic exposure group. The acute group received sodium fluoride (NaF) at a concentration of 0.23 mg/L through drinking water for 72–96 hours, while the chronic group was exposed to 0.0115 mg/L NaF for a duration of 90 days. The control group was maintained under identical conditions but provided with fluoride-free distilled water.

Fluoride Administration

Sodium fluoride was administered orally via drinking water to ensure uniform exposure. Fresh NaF solutions were prepared daily to maintain consistency in fluoride concentration and prevent degradation. All animals were housed under standard laboratory conditions with controlled temperature, humidity, and a 12-hour light–dark cycle. The rats were given normal food and water freely available at all times and observe dental condition.

3. Results and Discussion

Figure 1: Control

Experimental animal (Rattus norvegicus) with control group without exposure to sodium fluoride:

Figure 2: Acute

Experimental animal (Rattus norvegicus) with short term (acute) exposure to sodium fluoride shows that discolouration of teeth.

Figure 3: Chronic

Experimental animal (Rattus norvegicus) with long term (chronic) exposure to sodium fluoride causes degeneration of enamel and edges.

Continuous exposure to sodium fluoride (NaF) produced distinct changes in the teeth of *Rattus norvegicus*. In the acute exposure group (0.23mg/L NaF for 72-96 hrs), teeth exhibited a yellowish discoloration compared to the control group, indicating the initial stage of dental fluorosis. Under chronic exposure (0.0115mg/L NaF for 90 days), more severe effects were observed, including degeneration of the enamel surface and irregularities along the tooth edges. These alterations suggest a progressive impact of sodium fluoride toxicity on dental structures when exposure is prolonged.

4. Conclusion

The present study demonstrates that the sodium fluoride (NaF) toxic effect on teeth of experimental animals was observed in acute and chronic condation on the teeth of albino rats (*Rattus norvegicus*). Acute exposure to higher concentrations of NaF resulted in noticeable yellowish discoloration of the teeth, while chronic exposure, even at lower concentrations, caused enamel degeneration and edge deterioration. The findings of the present study are consistent with earlier reports on fluorosis in both experimental animals and humans. Fejerskov et al. (1990) and DenBesten & Li (2011) further described the structural and biochemical mechanisms underlying enamel hypo-mineralization caused by fluoride. Similarly, Buzalaf & Levy (2011) and Warren & Levy (2003) emphasized that chronic fluoride exposure leads to enamel discoloration, surface defects, and increased susceptibility to wear. The comparable observations in our rat model strengthen the translational relevance of animal studies in understanding human dental fluorosis. These findings indicate that while sodium fluoride has well-established cariostatic properties, excessive or prolonged exposure can lead to structural alterations in dental tissues, resembling early stages of dental fluorosis.

Overall, this study reinforces the importance of careful regulation of fluoride intake in both experimental and public health contexts. These findings also highlight the need for public health strategies that balance fluoride's beneficial effects in caries prevention with the potential risks of overexposure, ensuring optimal oral health outcomes across populations.

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